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Uranium Oxide Solar Cell

From nuclear waste to renewable energy: thin-film solar cells from depleted uranium oxide

BACKGROUND & MOTIVATION

- *Depleted uranium oxide (DUO), is an abundant and cheap waste product of nuclear fuel enrichment process*
- *Its supply will grow with the expected growth of the nuclear energy industry*
- *Solutions for reduction of the stockpile are needed*
- *DUO films have properties appealing for use in solar cells (e.g., band-gap tunability, low cost, abundance)*

INNOVATION

We propose to develop a proof-of-concept uranium oxide solar cell.

- *We have developed methods for rapid and cheap deposition of DUO as a thin film on various substrates*
- *Optical and electronic properties of the film can be tuned by variations in the deposition conditions*
- *This process will be used to form p-n junctions and fabricate proof-of-concept PV devices. DUO p-n junctions have not yet been demonstrated*
- *Thin uranium oxide film fabrication capability can be readily included to a standard nuclear fuel fabrication process.*

DESCRIPTION

DUO Films Production:

- *The uranium oxide films will be fabricated at the Target Fabrication Facility using standard physical vapor deposition (PVD) technique [I.O. Usov et al., J. Nucl. Mater. 437 (2013) 1]*
- *Undoped uranium oxide has p-type conductivity. To achieve n-type conductivity we will dope it with elements from the III-group of the Periodic Table (Al and B) substituting for oxygen.*

Colors of DUO films controlled by deposition conditions

Films Characterization and device fabrication:

- *Understanding of optical properties of uranium oxide is limited [Meek et al., Mater. Letts 59 (2005) 1085; Schoenes, J. Appl. Phys. 49 (1978) 1463]; with band gap estimated to be in the range 1.5 – 2.5 eV – optimal for use in PV.*
- *The band gap likely depends on, and can be controlled by the oxygen content, resulting in different oxide phases (UO_2, U_3O_7, U_3O_8, UO_3).*
- *Optical characterization of various oxide films, PV device fabrication and characterization will be done at Dr. Sykora's laboratories using approaches developed previously [e.g., M. Sykora et. al., ACS Nano. 2010, 4,6377.]*

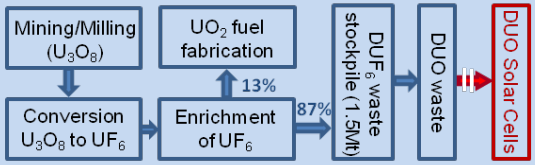
Current Technology Readiness Level (TRL) 3

We have a great deal of experience in uranium oxide films growth and PV devices fabrication.

ANTICIPATED IMPACT

Possible path to reduction of nuclear waste stockpile with the renewable energy and optoelectronics benefit.

- *Immediate potential sponsors include DOE, DOD, and nuclear energy industry, who are searching for civilian solutions for reduction of depleted uranium stockpile.*
- *Excellent radiation tolerance of uranium oxide to bombardment with energetic particles, makes it also attractive for space solar panel applications.*
- *Successful demonstration of p-n junction device will be of interest to PV community and also open an opportunity to make other radiation-hard electronic devices.*
- *Our vision of Solar-Nuclear Fuel Cycle:*



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